September 14, 2000

MEMORANDUM

SUBJECT: REVISED OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT AND RECOMMENDATIONS FOR THE REREGISTRATION ELIGIBILITY DECISION DOCUMENT FOR THIABENDAZOLE INCORPORATING REGISTRANT AND USDA COMMENTS (D267084, PC Codes 060101, 060102))

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The Thiabendazole (060101) and Thiabendazole Salt (060102) HED Risk Assessment for the Reregistration Eligibility Decision Document (RED) was issued in May 2000 . The Occupational and Residential Exposure Assessment supporting this document was issued in March 2000. The registrant and USDA responded with comments regarding these documents.

p. 5 of Risk Assessment Document:

"- statement that occupational risks exceed HED's level of concern, no statement of which risks exceed"

Several of the occupational handler scenarios reflecting use of baseline protective clothing exceed HED's level of concern defined by target MOEs of 100 for short- and intermediate-term dermal risk, and 100 for short- and intermediate-term inhalation risk. MOEs for occupational exposure risk at baseline (long sleeves, long pants, no gloves) averaged 56 for manual seed treatment, 32 for post-harvest activities and 77 for application to mushroom houses. Short- and intermediate-term dermal risks for these scenarios are mitigated with PPE (personal protective equipment) and/or engineering controls such that MOEs are > 100 and below HED's level of concern, except manual seed treatment. Manual seed treatment is expected to be used less often than commercial

seed treatment No suitable chemical specific data is available for estimating occupational exposure due to commercial seed treatment; however, a surrogate study indicates that exposure from large scale seed treatment with commercial equipment is relatively low (D. Jaquith, 3/00, D251077). The study was published in 1983. It is the Agency's understanding that current technology is such that the treatment system is closed and treatment systems are not manually operated. Therefore, exposures from a factory setting would not be expected to exceed that from manual seed treatment.

The exposure estimate for workers involved in post-harvest activities, ie., sorting/packing, derived in lieu of data should be considered to be very conservative for the following reasons: (1) it was assumed that all of the thiabendazole on the treated surface could be transferred to the skin. The chemical is usually part of a wax matrix and quantitative transfer to the skin is unlikely; and (2) the transfer coefficients for the hands were obtained from a field study in which contact with contaminated foliage was highly probable; a conveyor belt treatment line would be unlikely to have such a high degree of contact (probably restricted to fingertips only).

Residential risk estimates are not expected to exceed occupational post-application exposure and therefore do not exceed HED's level of concern. Non-occupational exposure may include application of thiabendazole-treated paints and exposure to thiabendazole-treated carpets.

p. 14 of Occupational and Residential Exposure Assessment Document.

"Target MOE or which exposures are unacceptable are never indicated."

The NOAELs for short term, intermediate term, long term and respiratory exposures were all 10 mg/kg/day. Therefore the risk calculations are the same for each exposure interval. The target MOEs were 100 in all cases

Calculations of risk indicate that the MOEs are more than <u>100</u> at baseline for the following scenarios:

1) Planting potato seed pieces (1)
2) Observing on tractor during planting of potato seed pieces (2)
3) Filling duster for potato seed pieces/Cutting potato seed pieces (3a-e)
4) Mixing/loading for post harvest treatment (6)
5) Applying paints containing TBZ with a paintbrush (8)
6) Applying paints containing TBZ with an airless sprayer (9)
7) Mixing/loading for mushroom houses (11)
8) Post application exposure from treated carpets/textiles/paper - Adult (12a)
9) tree injection (13) - no data but assumed to be negligible

The calculations of risk indicate that the MOEs are greater than 100 with additional PPE (gloves) for the following scenarios

1) Post harvest handling of treated commodities during sorting/culling/packing (7)
2) Spray application to mushrooms (10)

MOEs Ranged from less than 100 to over 300 for:

1) Post application exposure to treated carpet, textiles, or paper - Toddler (12b)
2) Post application exposure to treated carpet, textiles, or paper - Infant (12c)

MOEs were less than 100 for:

1) manual seed treatment (7)

There were no suitable data for:

1) commercial seed treatment (5)

OCCUPATIONAL AND RESIDENTIAL EXPOSURE CHAPTER

In this document, which is for use in EPA's development of the Thiabendazole (TBZ) Reregistration Eligibility Decision Document (RED), EPA presents the results of its review of the potential human health effects of occupational and residential exposure to Thiabendazole. Included is a discussion of the adequacy of the occupational and residential exposure data that support of the reregistration of Thiabendazole.

BACKGROUND

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For TBZ, the toxicological criteria are met by the identification of endpoints for estimating short-term and intermediate-term risk. Potential exposure can occur as a result of agricultural uses, post harvest applications, painting with formulations containing the fungicide.

Summary of Use Patterns of Formulations

Occupational-use products and homeowner-use products

At this time products containing TBZ are intended for occupational use. The only products containing TBZ intended for residential use would be paint/adhesive resulting from products mixed with TBZ during formulation/mixing..

TBZ is a fungicide formulated as a powder, dry flowable, or an emulsifiable concentrate. It is also used as a ready-to-use liquid for incorporation into paints, adhesives, and textiles and paper products.

According to the labels, TBZ is used to control fungal diseases, on various crops after harvest, some field applications are registered, seed treatment, treatment of potato seed pieces, and as an additive for paints and adhesives. It is registered on the following crops/products.

- **Post-Harvest Treatment:** citrus, apples, pears, mushrooms, avocados. potatoes, mushrooms, mangoes, bananas, sweet potato seed roots, sugar beets, ornamental bulbs and corms, reconstituted tobacco

- **Seed Field Crops:** potato seed pieces, sweet potato seed pieces, wheat, soybeans, clover, seed peas, chickpeas, dry beans.

- **Non-Food Crops:** ornamental bulbs and corms

- **Non-Crop Applications:** paints, adhesives, paper products, canvas textiles, nylon carpeting

Field application of TBZ can be aerial (fixed wing or helicopter), ground boom, or by chemigation. Post harvest application can be by dipping, spraying, or application during the waxing procedure for fruits and avocados. It can also be mixed with paints and adhesives or incorporated in the manufacture of textiles and carpeting.

Summary of Toxicity Concerns Relating to Occupational Exposures

Acute Toxicology Categories

TBZ is classified as category III for acute oral and dermal toxicities, category IV for primary eye irritation, category IV for primary dermal irritation, and category IV for dermal sensitization. No acute inhalation data are available. Inhalation NOAELs were derived from an oral study.

Other Endpoints of Concern

The TBZ Hazard Identification Assessment Review Committee report, dated July 21, 1999 indicates that there are toxicological endpoints of concern for TBZ. A summary of this information is presented in Table 1.

Table 1. Toxicological Endpoints of Concern for Thiabendazole

Exposure Routes	Exposure Duration	Dose (mg/kg/day)	Effect	Study	Uncertainty Factor	Comment
Dermal	Short-term	NOAEL 10	Decreased fetal body weights	Oral develop-mental Toxicity (rat)	100	MOE based on UF for inter-species (10x) extrapolation and intra-species variability(10x)
Dermal	Intermedi-ate-term	NOAEL10	Reduced body weight gain, histological changes in bone marrow, liver and thyroid	14-week oral feeding (rat)	100	MOE based on UF for inter-species (10x) extrapolation and intra-species variability (10x)
Inhalation	Any time period	NOAEL 10[a]	Increased Liver weight, splenic erythropoiesis and hemosiderosis	53 week chronic dog	100	MOE based on UF for inter-species (10x) extrapolation, intra-species variability(10x)

[a] Inhalation dose selected from oral values.

Conclusions

Handler Exposures & Assumptions

EPA has determined that there are potential exposures to mixers, loaders, applicators, or other handlers during usual use-patterns associated with thiabendazole. Based on the use patterns major exposure scenarios were identified for thiabendazole.:

2) planting potatoes
3) observer on tractor planting potato seed pieces
4) filling duster for potato seed treatment/cutting potato seed pieces (3a-e)
5) manual seed treatment at farm
6) commercial seed treatment
7) mixing/loading for post harvest treatments
8) exposure during post harvest handling of treated commodities
9) Applying paints containing TBZ to surfaces using a paintbrush
10) Applying paints containing TBZ to surfaces using an airless sprayer
11) application to mushroom houses
12) mixing/loading for mushroom houses
13) postapplication exposure to treated carpet, textiles, or paper
14) tree injection

In deriving exposure estimates for field applications the following assumptions were employed:

Unit exposures	=	From PHED Surrogate Exposure Guide or data from the scientific literature, as appropriate
Application rates	=	Representative label rates for example crops.
Acres/day	=	Standard HED Occupational/Residential default values based on application method, and modified as needed for specific crop/application method combinations (e.g. 350 acres per day for aerial/chemigation and 80 acres per day for ground boom) and utilizing other information as available.

As mentioned previously, no chemical-specific handler studies are available. Baseline dermal and inhalation exposure assessments using PHED Version 1.1 surrogate data are presented in Table 2. To address scenarios not covered by PHED it was necessary to use data from studies found in the scientific literature. Because the NOAELs are similar for the dermal and inhalation routes and both were obtained from oral dosing studies, the estimated exposures from dermal and inhalation routes were combined to yield a total exposure that was used for risk assessment.

Daily dermal exposure is calculated using the following formula when utilizing PHED:

Daily Dermal Exposure (mg ai/day) =
Unit exposure (mg ai/lb ai) x Use Rate (lb ai/A or lb ai/gal) x Daily Amount Treated (A/day or gal/day).

OR when using time normalized data from the scientific literature:

Daily Dermal Exposure (mg ai/day) = Unit exposure (mg ai/hr) x application rate of thiabendazole/application rate of surrogate x Daily Time (hrs/day)

These calculations of daily exposure to thiabendazole by handlers are used to estimate the daily dermal dose for those handlers.

Daily inhalation exposure is calculated using the following formula when using PHED:

Daily Inhalation Exposure (mg ai/day) =
Unit Exposure (μg ai/lb ai) x (1mg/1000μg conversion) x Use Rate (lb ai/A or lb ai/gal) x Daily Amount Treated (A/day or gal/day)

OR

Daily Inhalation Exposure (mg ai/day) = Unit Exposure (mg/hr) x application rate of thiabendazol)/application rate for surrogate x Daily Time (hrs/day)

These calculations of daily exposure to thiabendazole by handlers are used to estimate the daily inhalation dose for those handlers. Detailed calculations and the deveopment of models, where necessary are presented in Appendix A.

Table 2. Dermal and Inhalation Exposure to Thiabendazole(TBZ)

Exposure Scenario (Scenario #)	Dermal Unit Exposure	Inhalation Unit Exposure[a]	Maximum Application Rate[b]	Daily Acres Treated[c]	Daily Dermal Exposure (mg/kg/day)[de]	Daily Inhalation Exposure (mg/kg/day)
Mixer/Loader Exposure/Cutter (for potato seed treatment)						
Filling duster for potato seed pieces, located outside facility (Rocky seed)(3a)	22 mg/hr[e]	1.7 mg/hr	0.005/100 lbs	30	0.075	0.0097
Filling duster for potato seed pieces, located outside facility (Clean seed)(3b)	12 mg/hr	0.61	0.005/100 lbs	30	0.041	0.0035
Filling duster for potato seed pieces, located inside facility (Clean seed)(3c)	2.0 mg/hr	0.15 mg/hr	0.005/100 lbs	30	0.0069	0.00086
Cutting Potato Seed Pieces, Complete Operation Inside (3d)	0.80 mg/hr	0.037 mg/hr	0.005/100 lbs	30	0.0027	0.00021
Cutting Potato Seed Pieces, Cutter Inside and Duster Outside (3e)	0.14 mg/hr	0.042 mg/hr	0.005/100 lbs	30	0.00048	0.00024
Mixing/loading for post harvest treatment of commodities (6)	2.9 mg/lb ai	0.0012 mg/lb ai	NA	NA	0.011	0.0000074
Mixing/loading for mushroom spraying (11)	2.9 mg/lb ai	0.0012 mg/lb ai	0.12 lb ai/500 ft^2	NA	0.030	0.000021
Applicator Exposure (Planter/Observer for Potato Seed Application)						
Applying paints containing TBZ to surfaces, paintbrush (8)	180	0.28	5 g/gal; 2 gal/day	NA	0.034	8.5×10^{-5}

Exposure Scenario (Scenario #)	Dermal Unit Exposure	Inhalation Unit Exposure[a]	Maximum Application Rate[b]	Daily Acres Treated[c]	Daily Dermal Exposure (mg/kg/day)[de]	Daily Inhalation Exposure (mg/kg/day)
Applying paints containing TBZ to surfaces, airless sprayer (9)	38	0.83	5 g/gal; 5 gal/day	NA	0.018	6.5×10^{-4}
Planting potato seed pieces (1)	0.71 mg/hr	0.037 mg/hr	0.005 lb/100 lbs	30	0.0024	0.00021
Observer on tractor planting potatoes (2)	0.63 mg/hr	0.027 mg/hr	0.005 lb/100 lbs	30	0.0026	0.000086
Manual seed treatment (4)	9.4 mg/lb ai	0.0016 mg/lb ai	0.005 lb/100lbs	NA	0.18	0.00005
Commercial seed treatment (5)	No data, not expected to exceed manual seed treatment	No data, not expected to exceed manual seed treatment	No data, not expected to exceed manual seed treatment	NA	No data, not expected to exceed manual seed treatment	No data, not expected to exceed manual seed treatment
Spraying mushrooms (10)	12	0.94	0.12 lb ai/500 ft²	NA	0.12	0.016
Tree injection (13)	No data	No data	No data	NA	Not data, considered negligible	Not data, considered negligible
Post Harvest/Post Application Exposure						
Post harvest exposure during sorting/packing/culling (7)	NA	Negligible	NA	NA	0.31	Negligible
Post application exposureto treated carpet, textiles, or paper - Adult (12a)	NA	NA	NA	NA	0.01-0.10	Negligible
Post application exposureto treated carpet, textiles, or paper - Toddler (12b)	NA	NA	NA	NA	0.02-0.17	Negligible
Post application exposureto treated carpet, textiles, or paper - Infant (12c)	NA	NA	NA	NA	0.03-0.26	Negligible

a Inhalation exposure represents no respirator.
b Application rates were taken by examination of product labels.
c Daily acres treated values are from EPA HED estimates of acreage that could be treated or volume handled in a single day for each exposure scenario of concern.
d Daily Dermal Exposure (mg/kg/day) = Unit Exposure (mg/lb ai) * Appl. rate (lb ai/A) * Acres Treated ÷ 70 kg x dermal absorption factor of 0.6 OR
mg/hr x hrs/day x Appl rate of TBZ/Appl rate of surrogate ÷ 70 kg x dermal absorption factor of 0.6 OR see Appendix A for calculation of post harvest culling/sorting/packing operations.
e potato treatment exposure estimates were derived from a study in which 5 percent captan was used and assumes 6 hours of exposure (Stevens, et al., see Appendix A)

Table 3. Intermediate-term MOEs for TBZ at Baseline and with Mitigation Measures

Exposure Scenario (Scenario #)	Baseline Daily Dose[a] (mg/kg/day)	Baseline MOEs[b]	Risk Mitigation Measures	
			Additional PPE[c]	
			Daily Dose[e] (mg/kg/day)	MOE[b]
Mixer/Loader Exposure and Dose Levels (includes Cutters for potato seed treatment)				
Filling duster for potato seed pieces, located outside facility (Rocky seed)(3a)	0.085	120	NA	NA
Filling duster for potato seed pieces, located outside facility (Clean seed)(3b)	0.045	222	NA	NA
Filling duster for potato seed pieces, located inside facility (Clean seed)(3c)	0.0078	1300	NA	NA
Cutting Potato Seed Pieces, Complete Operation Inside (3d)	0.0029	3400	NA	NA
Cutting Potato Seed Pieces, Cutter Inside and Duster Outside (3e)	0.00072	14000	NA	NA
Mixing/loading for post harvest treatment of commodities (6)	0.011	910	NA	NA
Mixing/loading for mushroom treatment (11)	0.030	333	0.0024	4200

Exposure Scenario (Scenario #)	Baseline Daily Dose[a] (mg/kg/day)	Baseline MOEs[b]	Risk Mitigation Measures	
			Additional PPE[c]	
			Daily Dose[e] (mg/kg/day)	MOE[b]
Applicator Exposures and Dose Levels (includes Obseerver for Potato Treatment)				
Applying paints containing TBZ to surfaces, paintbrush (8)	0.034	290	NA	NA
Applying paints containing TBZ to surfaces, airless sprayer (9)	0.018	560	NA	NA
Planting potato seed pieces (1)	0.0026	3800	NA	NA
Observer on tractor planting potatoes (2)	0.0023	430	NA	NA
Manual seed treatment (4)	0.18	56	NA	NA
Commercial seed treatment (5)	No data; not expected to exceed manual	No data; not expected to exceed manual	No data; not expected to exceed manual	No data; not expected to exceed manual
Application to mushroom houses (11)	0.13	77	0.089	112
Post Harvest and Post Application Exposures and Dose Levels				
Post harvest exposure during sorting/packing/culling (7)	0.31	32	0.031	320

Exposure Scenario (Scenario #)	Baseline Daily Dose[a] (mg/kg/day)	Baseline MOEs[b]	Risk Mitigation Measures	
			Additional PPE[c]	
			Daily Dose[e] (mg/kg/day)	MOE[b]
Post application exposure to treated carpet, textiles, or paper - Adult (12a)	0.01-0.1e	100-1000	NA	NA
Post application exposure to treated carpet, textiles, or paper - Toddler (12b)	0.02-0.17	59-590	NA	NA
Post application exposure to treated carpet, textiles, or paper - Infant (12c)	0.03-0.26	39-390	NA	NA

a Baseline Daily Dose (mg/kg/day) = Baseline Daily Exposure (mg/day)/Body weight (70 kg). Baseline exposures are reported in Table 2.
b Dermal MOE values calculated using the following equation: MOE = NOEL (mg/kg/day)/Dermal Dose (mg/kg/day), where dermal NOEL = 5.0 mg/kg/day and an MOE of 100 is required.
c Additional PPE consists of a single layer of clothing and gloves
d Daily Dermal Dose (mg/kg/day) = [(Unit Dermal Exposure (mg/lb ai) * Max. App. Rate (lb ai/A) * Max. Treated)/Body Weight (70 kg)]
e Derived from a literature study (Ross, et al., see Appendix A)

Table 7. Exposure Scenario Descriptions for Uses of Thiabendazole (TBZ).

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Mixer/Loader Exposure			
Mixing Liquid Formulations (6,11)	PHED V1.1	textbook/use report for mushrooms (see Appendix A)	**Baseline:** Hands, dermal, and inhalation = AB grades. Dermal = 72 to 122 replicates; hands = 53 replicates; inhalation = 85 replicates. High confidence in all data. No protection factor was needed to define the unit exposure. **PPE:** The same dermal data are used as for the baseline, and chemical resistant glove data are used for hands. Hand data are AB grades with 59 replicates. High confidence in hand data.
Applicator Exposure			
Applying paints with a paintbrush (8)	PHED V1.1	2 gallons of paint per day	**Baseline:** Hands, = B grades.; inhalation and dermal = C grade Dermal = 14 to15 replicates; hands = 15 replicates; inhalation = 15replicates. Low confidence for dermal; medium for inhalation. PHED data were used for baseline, no PFs were necessary.
Applying paints with an airless sprayer (9)	PHED V1.1	5 gallons of paint per day	**Baseline:** Hands, dermal, = B grades.; inhalation = C grade Dermal = 15 replicates; hands = 15 replicates; inhalation = 15replicates. High confidence for dermal; medium for inhalation. PHED data were used for baseline, no PFs were necessary.

Table 7. Exposure Scenario Descriptions for Uses of Thiabendazole (TBZ) (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Planting potato seed pieces (1)	Stevens et. al (see Appendix A); PHED V1.1	6 hours per day	Weak study from the scientific literature, not all body areas were represented; ratios of exposure inside and outside the clothing of mixer/loaders pouring wettable powders was used to address these deficiencies (see Appendix A). Previous reports used for work duration.
Observer on tractor planting potatoes (2)	Stevens et. al (see Appendix A); PHED V1.1	6 hours per day	Weak study from the scientific literature, not all body areas were represented; ratios of exposure inside and outside the clothing of mixer/loaders pouring wettable powders was used to address these deficiencies (see Appendix A). Previous reports used for work duration.
Manual seed treatment (4)	Fenske et al (see Appendix A.	8 hour per day. Data from study extrapolated to farm size.	Literature study used for estimate. Quality assurance data not available; 12 replicates conducted by 4 workers. Eight hours probably highly conservative.
Commercial Seed Treatment (5)	No data	8 hours per day	Exposure was assumed to be less than manual seed treatment; the only available data source contained almost all non-detect samples.
Spray Application to Mushrooms (10)	PHED V1.1	10 houses per day	**Baseline:** Hands = BC grades; dermal = C grade; inhalation = ABC grades. Dermal = 13 replicates; hands = 9 replicates; inhalation = 13 replicates. Low confidence in all data. No protection factor was needed to define the unit exposure. **PPE:** The same dermal data are used as for the baseline, and chemical resistant glove data are used for hands. Hand data are BC grades with 4 replicates. Low confidence in hand data.

Table 7. Exposure Scenario Descriptions for Uses of Thiabendazole (TBZ) (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a] (8-hr work day)	Comments[b]
Post harvest treatment Exposures			
Mixer/loader for post harvest treatments (6).	PHED V1.1	2000 boxes per hour; 8 hours per day	**Baseline:** Hands, dermal, and inhalation = AB grades. Dermal = 72 to 122 replicates; hands = 53 replicates; inhalation = 85 replicates. High confidence in all data. No protection factor was needed to define the unit exposure.
Post treatment exposures during sorting/packing/culling (7)	Model developed	8 hour work day	Model developed from USDA data, Highest Average Field Trial (HAFT), and a study from the scientific literature. Apple is considered to represent a "standard" fruit. Considered highly conservative.
Post application from carpets, textilesn and paper (12a-c)	Ross, et al. (see Appendix A); Residentia l SOPs	8 hrs per day; 5 percent tansfer	Study does not match scenario; provides very conservative estimates

[a] Standard Assumptions based on an 8-hour work day as estimated by HED. BEAD data were not available.

[b] Data grades are defined by EPA SOP for meeting Subdivision U Guidelines. Acceptable grades are matrices with grades A and B data. Data confidence are assigned as follows:

High= grades A and B and 15 or more replicates

Medium = grades A, B, and C and 15 or more replicates; Low = grades A, B, C, D, and E or any combination of grades with less than 15 replicates

(RISK)

Occupational and Residential

The NOAELs for short term, intermediate term, long term and respiratory exposures were all 10 mg/kg/day. Therefore the risk calculations are the same for each exposure interval.

Calculations of risk indicate that the MOEs are more than 100 at baseline for the following scenarios:

1) Planting potato seed pieces (1)
2) Observing on tractor during planting of potato seed pieces (2)
3) Filling duster for potato seed pieces/Cutting potato seed pieces (3a-e)
4) Mixing/loading for post harvest treatment (6)
5) Applying paints containing TBZ with a paintbrush (8)
6) Applying paints containing TBZ with an airless sprayer (9)
7) Mixing/loading for mushroom houses (11)
8) Post application exposure from treated carpets/textiles/paper - Adult (12a)
9) tree injection (13) - no data but assumed to be negligible

The calculations of risk indicate that the MOEs are greater than 100 with additional PPE (gloves) for the following scenarios

1) Post harvest handling of treated commodities during sorting/culling/packing (7)
2) Spray application to mushrooms (10)

MOEs Ranged from less than 100 to over 300 for:

1) Post application exposure to treated carpet, textiles, or paper - Toddler (12b)
2) Post application exposure to treated carpet, textiles, or paper - Infant (12c)

MOEs were less than 100 for:

1) manual seed treatment (7)

There were no suitable data for:

1) commercial seed treatment (5)

Discussion of Risk Estimates

Four general parameters enter into the calculations for handler dermal exposure: unit exposure value (derived from PHED V1.1 or the scientific literature); application rate (from product labels); area treated/amount handled in a typical workday (estimates based on available usage information); and the worker's body weight (taken from the Exposure Factors Handbook). The relative value of each of these parameters is described below:

- PHED values are assumed to be approximately median exposures (i.e. central tendency point estimates) over the available data. That is, 50 percent of workers doing the same activity would be expected to have *higher* unit exposures, and 50 percent would be expected to have *lower* unit exposures. These values are derived from actual exposure studies where the same formulation types, equipment, and methods were employed as some used for TBZ. Typically, there is high variability among replicates in exposure studies, often covering a range of orders of magnitude. EPA considers unit exposure values derived from PHED to be representative of typical exposures.

- Application rates are the maximum labeled rates for the sites identified. Usually applications are made at varying rates depending a number of factors including the degree of the pest problem and environmental considerations.

- Area treated per day or amount handled for the various scenarios are either standard values used by the former Occupational and Residential Exposure Branch, values obtained from experts in the associated field, or analysis of the scientific literature. These were arrived at after much internal discussion, and are considered to represent typical to reasonable high-end acreages/amounts handled.

- Body weight is the standard 70 kg value for adults, which is routinely used by the Agency. This is identified in the Exposure Factors Handbook as the mean body weight for both sexes of adults in all age groups combined, rounded to one significant figure.

Data Gaps in Both Dermal and Inhalation Assessment

There are no exposure data for thiabendazole. The Agency was forced to use either surrogate data from the scientific literature, PHED and/or modeling techniques for the all of the exposure scenarios. Use information should be considered conservative. These estimates of exposure provide the Agency's best estimates of exposure in lieu of additional data. **However some of these estimates should be considered very conservative, particularly the post harvest handling of commodities and the post application exposures to carpet residues. The former assumes that ALL of the residue on the surface of the commodity is available for transfer. This is not likely to be the case. The latter was derived from a surface spray study, not a product that was treated during manufacture. The residues measured were SURFACE ONLY whereas the application during manufaccture would be likely to have much of the material incorporated into the carpet backing where it would be inaccessible. Since pesticides tend to bind to carpet with time, the TBZ in the fibers would probably also bind during storage of the carpet prior to sale.**

cc: Thiabendazole files/060101/060102
R. Kent (RRB4/7509C)

DOCUMENTATION OF OCCUPATIONAL EXPOSURE ASSESSMENT FOR THE THIABENDAZOLE REREGISTRATION ELIGIBILITY DOCUMENT (RED)

I. POTATO SEED PIECE TREATMENT

The Agency has no data addressing the potential exposures of individuals using thiabendazole to treat potato seed pieces prior to planting. Exposures were estimated using surrogate data from a study published in the scientific literature measuring worker exposure to captan during potato seed treatment. In order to adjust for technical problems with that study, the estimates were adjusted using information from the Pesticide Handlers Exposure Database V1.1 (1). A description of the surrogate study and the adjustments is presented below.

CITATIONS: **Stevens, E.R. and J.E. Davis (1981) Potential Exposure of Workers During Seed Potato Treatment with Captan. Bull. Environm. Contam. Toxicol. 26, 681-688.**

Davis, J.E. and E.R. Stevens. The Exposure of Workers During Seed Potato Treatment with Captan: Preliminary Report. Wenatchee Pesticides Research Branch, Environmental Toxicology Division, Health Effects Research Laboratory - RTP

Potential dermal and respiratory exposures of workers to captan were monitored during the preparation and planting of potato seed pieces. Workers filling the hoppers of seed dusting machines, cutting and sorting potatoes on seed cutting machines located near the dusters, a tractor driver planting the treated seed potatoes, and a planter observer riding behind the planter containing treated seed potatoes were monitored. The product, 5% Captan Seed Protectant, was applied at a rate of 1.5 lb of dust (0.075 lb ai) per 100 lbs of potatoes. The material was dispensed from 50 lb bags.

The study was conducted at two separate facilities. The first facility was one in which the duster was located just outside the doorway and the cutting machine inside the building with a plastic sheet to protect the workers inside from the blowing dust. A conveyor belt from the cutting machine to the duster ran through a slot in the sheet. At this site there were often small stones in with the potatoes which were manually removed from the dusting machine cylinder by the worker who also filled the hopper. This procedure was considered by the authors to be atypical since rocky seed potatoes slow down the planting process and growers would not continue to buy from a facility that produced a rocky seed in the past. This worker also covered the treated potatoes with a tarp and rinsed the inside of the truck with bleach solution prior to processing a new batch of seed. There were 4 workers operating the cutting machine. They were located 1-3 meters from the duster. These workers also swept around the cutting machine between loads.

At the second site both the cutting machine and the duster were located inside the building. When wind was not excessive the doors remained open to facilitate changing trucks. Six cutting machine operators were located 1-5 meters from the dusting machine. One worker adjusted the conveyor carrying treated potatoes to the truck. Cutting machine operators swept the area between truck loads. It took approximately 3/4 to 2 hours to prepare a truckload of seed potatoes.

A tractor driver and a planter observer were also monitored during the planting procedure. This worker also transferred treated potatoes to the planter hoppers, often a dusty operation. The tractor was equipped with a closed cab. The observer also assisted in the transfer since that worker got inside the truck to kick down potatoes as the truck became empty. These workers were also completely clothed and wore canvas-backed gloves. Application of 2 filling and planting cycles took from 3/4 hour to 1-1/2 hour. Workers were monitored for exposure of the hands, face, and neck as well as respiratory exposure.

Workers wore head coverings, and long-sleeved shirts or jackets. Therefore the authors estimated dermal exposure only to the face, neck, and hands. Respiratory protection was not worn by any of the workers at the first site. At the second site some workers wore paper dust masks which were replaced by modified respirators for monitoring purposes. The workers operating the cutting machine wore rubber gloves. Their hand exposure was not monitored. The dusting machine operator wore canvas-backed leather gloves and his hands were monitored.

Dermal exposures, other than the hands were monitored using gauze patches attached outside the clothing to both shoulders and the upper centers of the back and chest. Respiratory exposure was measured using modified respirators with gauze-faced pads as the collection medium. Hand exposures were measured using an alcohol rinse. Exposure pads were placed in an ice chest prior to transport to the analytical laboratory where they were stored under refrigeration. Pads were analyzed within 24 hours of transport to the laboratory. Entire respirator pads or 25 cm^2 portions taken from the center of dermal pads were extracted with 50 mL of toluene and dried with anhydrous sodium sulfate. Extracts were analyzed by gas chromatography with an electron capture detector.

Exposures were calculated for the head/neck, hands, and the respiratory route. The following surface areas were used for estimation of dermal exposure: Face, 650 cm^2, back of neck, 110 cm^2, front of neck 150 cm^2. Hand exposure was obtained from both hand rinses and the respiratory component from the respirator pads. No correction for storage of extracts and hand rinses or efficiency of respirator pads is possible and these exposure values must be considered to be the minimum possible. The results of exposure monitoring are presented in Table A1.

Extrapolation of Exposure Values to Address Other Parts of the Body

It is evident that many of the tasks involved considerable contact with treated product or contaminated equipment. Restriction of the dermal exposure values to head, neck and hands could appreciably underestimate exposure. The Pesticide Handlers Exposure Database (PHED, V 1.1) has no data addressing potato seed treatment. The nearest scenario is the open mixing/loading of wettable powders. This scenario resulted in exposure values when a single layer of clothing and gloves are worn of; 0.0776 mg/lb ai for head and neck; 0.0760 mg/lb ai for upper and lower arm, chest, back, thigh, and lower leg; and 0.0138 mg/lb ai for hand. This data set is considered to be of medium confidence (1). The dermal exposure for areas under the clothing was very similar to that of the head/neck area. Therefore total dermal exposure (excluding hands) is considered to be twice the amount reported by the authors for the potato seed study. Revised exposure values are presented in Table A2. Exposure estimates for the hands, head/neck area, and respiratory route remain unchanged. It is recognized that this extrapolation is associated with a high degree of uncertainty but, in lieu of additional data, provides the Agency's best estimate of the exposures for this scenario.

Table A1. Potential Exposure of Workers to Captan During Potato Seed Treatment and Planting. Numbers in parentheses are the number of replicates.

Operation	Exposure (mg/hr)			
	Dermal (Face and Neck)	Dermal (Hands)	Total Dermal	Respiratory
Filling Duster Located Outside (Rocky Seed)	7.2 ± 2.2 (3)	7.6 ± 5.5 (3)	15 ± 6 (3)	1.7 ± 0.6 (5)
Filling Duster Located Outside (Clean Seed)	4.5 ± 0.2 (3)	3.0 ± 2.0 (3)	7.5 ± 2.0 (3)	0.61 ± 0.23 (3)
Filling Duster Located Inside (Clean Seed)	0.95 ± 0.41 (9)	0.093 ± 0.068 (7)	1.2 ± 0.4 (7)	0.15 ± 0.12 (7)
Cutting, Cutter Inside and Duster Outside	0.070 ± 0.42 (12)			0.042 ± 0.034 (12)
Cutting, Complete Operation Inside	0.40 ± 0.41 (18)			0.037 ± 0.036 (18)
Tractor Driving Pulling Planter	0.34 ± 0.14 (5)	0.033 ± 0.016 (5)	0.37 ± (5)	0.037 ± 0.020 (10)
Observer Riding on Rear of Planter	0.31 ± 0.14 (5)	0.015 ± 0.012 (5)	0.33 ± 0.13 (5)	0.027 ± 0.031 (10)

Table A2. Revised Potential Exposure of Workers to Captan During Potato Seed Treatment and Planting. Numbers in parentheses are the number of replicates. Estimates of dermal exposure for areas other than the hands were derived from mixer/loader data from PHED V1.1.

Operation	Unit Exposure (mg/hr)			
	Dermal (Other than hands)	Dermal (Hands)	Total Dermal	Respiratory
Filling Duster Located Outside (Rocky Seed)	14 (3)	7.6 ± 5.5 (3)	22 (3)	1.7 ± 0.6 (5)
Filling Duster Located Outside (Clean Seed)	9.0 (3)	3.0 ± 2.0 (3)	12 (3)	0.61 ± 0.23 (3)
Filling Duster Located Inside (Clean Seed)	1.9 (9)	0.093 ± 0.068 (7)	2.0 (7)	0.15 ± 0.12 (7)
Cutting, Cutter Inside and Duster Outside	0.14 (12)		0.14 (12)	0.042 ± 0.034 (12)
Cutting, Complete Operation Inside	0.80 (18)		0.80 (18)	0.037 ± 0.036 (18)
Tractor Driving Pulling Planter	0.68 (5)	0.033 ± 0.016 (5)	0.71 (5)	0.037 ± 0.020 (10)
Observer Riding on Rear of Planter	0.62 (5)	0.015 ± 0.012 (5)	0.63 (5)	0.027 ± 0.031 (10)

Calculation of Exposures of Potato Planting Workers to Thiabendazole

Assumptions

1) An average worker weighs 70 kg.

2) Approximately 30 acres of potatoes can be planted in one day (2).

3) The TBZ formulations applied are 0.5 percent dusts, applied at a rate of 1 lb of formulation per 100 lbs of cut seed (0.005 lb ai/100 lbs seed pieces) as specified according to all of the labels for potato seed products.

4) Workers wear, at a minimum, long sleeve shirts, long pants, shoes and socks. Protective clothing is not specified on some labels. Others require respirators, protective gloves, and aprons for mixer/loaders.

5) The treated seed is planted at a rate of 1000 to 2880 pounds of seed potatoes per acre, depending on the spacing between and within rows (2,3). This results in a total of 30,000 - 86000 lb of seed per day.

6) The size of a potato farm varies from state to state. Using the states of Idaho and Maine as examples the distribution of farm sizes is presented in Table A3 (4).

7) Approximately 6 hours per day are spent planting potatoes. This number was derived from a use report for application of azinphos methyl to potatoes (5). The approximate number of acres treated per day is fairly close to the estimate for planting. It was therefore assumed that the times for both planting and pesticide applications are similar. Workers preparing the seed pieces are assumed to work for the same period of time.

8) Planting of potatoes requires 3 to 25 days, depending on farm size (see Table A3). This results in an intermediate exposure scenario with a NOAEL of 10 mg/kg/day for both the dermal and respiratory routes (6).

9) Dermal absorption of thiabendazole is 60 percent (6).

10) The ratio of active ingredient used in thiabendazole treatment compared to the captan used in the surrogate study is 0.005 lb ai/100 lbs potatoes to 0.075 lb ai/100 lbs potatoes. The amounts treated/planted are the same.

Table A3. Estimated Farm Sizes and Days Required for Planting of Potatoes in Two Major Potato-Producing States.

State	Farm Size (A)	No. Farms	Cumul.	Cumul. %	Percentile	Days to Plant[1]
Idaho	0.1 to 0.9	11	11	0.7		
	1.0 to 4.9	24	35	2.2		
	5.0 to 14.9	42	77	4.8		
	15.0 to 24.9	74	151	9.3		
	25.0 to 49.9	221	372	23		
	50.0 to 99.9	285	657	40.7		
	100.0 to 249.9	478	1135	70.2	50th	8
	250.0 to 499.9	301	1436	88.9	75th	17
	500.0 to 749.9	103	1539	95.2	95th	25
	750.0 to 999.9	34	1573	97.3		
	1000.0 to 1999.9	37	1610	99.6		
	2000.0 to 2999.9	3	1613	99.8		
	3000 or more	3	1616	100		
	TOTAL	1616	808			
Maine	0.1 to 0.9	70	70	8.9		
	1.0 to 4.9	74	144	18.3		
	5.0 to 14.9	54	198	25.1		
	15.0 to 24.9	40	238	30.2		
	25.0 to 49.9	75	313	39.7		
	50.0 to 99.9	125	438	55.6	50th	3
	100.0 to 249.9	243	681	86.4	75th	8
	250.0 to 499.9	67	748	94.9	95th should be about 500 A	17
	500.0 to 749.9	22	770	97.7		
	750.0 to 999.9	14	784	99.5		
	1000 or more	4	788	100		
	TOTAL	788	394			

[1] High acreage of frequency class used for estimation of planting time.

Applicator Exposure (Potato Planting):

Dermal Exposure (Potato Planting):

Dermal exposure (mg/kg/day) = 6 hrs/day x 0.71 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.0024 mg/kg/day

Respiratory Exposure (Potato Planting):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.037 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.00021 mg/kg/day

Total Exposure (Potato Planting):

Total Exposure (mg/kg/day) = 0.0024 mg/kg/day + 0.00021 mg/kg/day

= 0.0026 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.0026 mg/kg/day = 3800

Potato Planting Observer Exposure Estimates:

Dermal Exposure (Potato Planting Observer):

Dermal exposure (mg/kg/day) = 6 hrs/day x 0.63 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.0022 mg/kg/day

Respiratory Exposure (Potato Planting Observer):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.015 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.000086 mg/kg/day

Total Exposure (Potato Planting Observer):

Total Exposure (mg/kg/day) = 0.0022 mg/kg/day + 0.000086 mg/kg/day

= 0.0023 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.0023 mg/kg/day = 4300

For workers filling the seed duster:

Filler, Duster Outside (rocky seed):

Dermal Exposure (Filler, duster outside, rocky seed):

Dermal exposure (mg/kg/day) = 6 hrs/day x 22 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.075 mg/kg/day

Respiratory Exposure (Filler, duster outside, rocky seed):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 1.7 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.0097 mg/kg/day

Total Exposure (Filler, duster outside, rocky seed):

Total Exposure (mg/kg/day) = 0.075 mg/kg/day + 0.0097 mg/kg/day

= 0.085 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.085 mg/kg/day = 120

Filler, Duster located outside (clean seed):

Dermal Exposure (Duster located outside, clean seed):

Dermal exposure (mg/kg/day) = 6 hrs/day x 12 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.041 mg/kg/day

Respiratory Exposure (Duster located outside, clean seed):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.61 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.0035 mg/kg/day

Total Exposure (Duster located outside, clean seed):

Total Exposure (mg/kg/day) = 0.041 mg/kg/day + 0.0035 mg/kg/day

= 0.045 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.045 mg/kg/day = 222

Filler, Duster located inside (clean seed):

Dermal Exposure (Filler, duster located inside, clean seed) :

Dermal exposure (mg/kg/day) = 6 hrs/day x 2.0 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.0069 mg/kg/day

Respiratory Exposure (Filler, duster located inside, clean seed):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.15 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.00086 mg/kg/day

Total Exposure (Filler, duster located inside, clean seed):

Total Exposure (mg/kg/day) = 0.0069 mg/kg/day + 0.00086 mg/kg/day

= 0.0078 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.0078 mg/kg/day = 1300

Cutting, Cutter Inside and Duster located outside (hands not measured):

Dermal Exposure (Cutting, Cutter Inside and Duster located outside):

Dermal exposure (mg/kg/day) = 6 hrs/day x 0.14 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.00048 mg/kg/day

Respiratory Exposure (Cutting, Cutter Inside and Duster located outside):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.042 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.00024 mg/kg/day

Total Exposure (Cutting, Cutter Inside and Duster located outside):

Total Exposure (mg/kg/day) = 0.00048 mg/kg/day + 0.00024 mg/kg/day

= 0.00072 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.00072 mg/kg/day = 14000

Cutter, Complete Operation Inside (Hands not measured):

Dermal Exposure (Cutter, Complete Operation Inside):

Dermal exposure (mg/kg/day) = 6 hrs/day x 0.80 mg/hr x 0.60 x 0.005/0.075 ÷ 70 kg

= 0.0027 mg/kg/day

Respiratory Exposure (Cutter, Complete Operation Inside):

Respiratory exposure (mg/kg/day) = 6 hrs/day x 0.037 mg/hr x 0.005/0.075 ÷ 70 kg

= 0.00021 mg/kg/day

Total Exposure (Cutter, Complete Operation Inside):

Total Exposure (mg/kg/day) = 0.0027 mg/kg/day + 0.00021 mg/kg/day

= 0.0029 mg/kg/day

With a NOAEL of 10 mg/kg/day the resulting MOE would be:

MOE = 10 mg/kg/day ÷ 0.0029 mg/kg/day = 3400

II. MANUAL SEED TREATMENT (at farm):

The Agency has no data addressing the potential exposures of workers using thiabendazole to manually treat seed prior to planting. The exposure estimates were derived from a surrogate study found in the scientific literature in which worker exposure to lindane was monitored during application of lindane to wheat seed.

CITATION: Fenske, R.A., A.M. Blacker, S.J. Hamburger, and G.S. Simon (1990) Worker Exposure and Protective Clothing Performance During Manual Seed Treatment with Lindane. Arch. Environ. Contam. Toxicol. 19, , 190-196.

Dermal and respiratory exposures of 4 workers during the manual treatment of winter wheat at a commercial wheat farm in South Dakota. The operations are considered to be representative of manual seed treatments in the midwest. A dust formulation containing 18.75 percent lindane, packaged in 10 lb bags was applied at the label rate of 2 ounces per bushel of seed. A total of 720 bushels of seed were treated. The treatment procedure involved the addition of grain to a 4 compartment, 12 bushel grain drill. The label instructions indicate the user is to fill the drill box half full of seed and add half of the formulation. The seed and formulation are then mixed with a stick. The rest of the grain is then added and the procedure repeated. After thorough mixing the seed was removed by a vacuum. Workers monitored in this study did not participate in the vacuuming procedure.

Each mixing consisted of the application of 24 oz of the formulation to 12 bushels of grain. A plastic scoop, cut from a plastic bottle and determined to hold 12 oz of formulation, was used to

remove the powder from the bag. The scoop was used to spread the formulation evenly over the seed.

Each replicate consisted of five mixings conducted by each of the four workers. The mixing periods averaged 24 minutes and were separated by 10-20 minute breaks. This was considered to be equal to one "work period". During this time a worker handled 120 oz of formulation or 1.4 lb of active ingredient. Each volunteer performed the tasks three times (total of 60 mixings), yielding a total of 12 work periods. During treatments the workers wore the label required long sleeve shirt, long pants, gloves, and a pesticide respirator. All clothing was new and/or prewashed to avoid confounding analytical problems. The workers did not remove their gloves during the procedure but did during breaks.

Dermal exposures were monitored using gauze dosimeters encased in an envelope with a 5.6 cm diameter circle exposed to the environment. Dosimeters were either attached to the clothing or taped to the skin on the chest, back, shoulders, forearms, upper legs, or lower legs. Two sets of dosimeters were used, one outside the clothing and the other inside the work garments. Care was taken to avoid overlap of the dosimeters, which could confound the results of the inner monitors. Surface areas were assumed to be those outlined in the Agency's Pesticide Assessment Guidelines, Subdivision U (7).

Dermal exposure of the hands was monitored by hand wash with 250 mL of 10 percent isopropanol. A plastic bag was wrapped around the wrist and the bag shaken for about 30 seconds. This procedure was repeated 3 times, resulting in a final volume of 750 mL for each hand. Hand rinses were conducted immediately prior to the exposure period and again immediately after. Approximately 75 mL was transferred to a glass jar for storage.

Dosimeters were removed immediately after the exposure period and maintained at 4°C during shipment and storage.

The results of exposure monitoring are presented in Table A4.

Table A4. Exposures of Workers Applying Lindane as a Seed Treatment at a Rate of 0.64 Pounds of Active Ingredient per 60 Bushels of Grain (3600 lbs of seed, total 1.4 lb ai). Values used for exposure estimation are in boldface.

Body Region	Monitor Location	Exposure (mg)			Exposure (mg/lb ai)	
		Mean	Median	Range	Mean	Median
Chest	Outer	3.21	2.43	0.92-7.84	2.3	1.7
Back	Outer	2.48	2.48	0.85-4.58	1.8	1.8
Forearms	Outer	17.75	15.25	5.57-51.79	13.0	11.0
Upper arms	Outer	4.43	3.88	0.99-10.10	3.2	2.7
Upper legs	Outer	33.96	20.46	2.90-132.55	24.0	15
Lower legs	Outer	1.34	9.64	0.43-5.95	0.96	6.9
Chest	**Inner**	**0.45**	**0.44**	**0.07-0.71**	**0.32**	**0.31**
Back	**Inner**	**0.71**	**0.52**	**0.11-2.59**	**0.51**	**0.37**
Forearms	**Inner**	**5.43**	**3.46**	**1.31-16.70**	**3.9**	**2.5**
Upper arms	**Inner**	**1.12**	**0.79**	**0.12-2.91**	**0.80**	**0.56**
Upper legs	**Inner**	**2.88**	**2.18**	**0.08-9.32**	**2.1**	**1.6**
Lower legs	**Inner**	**0.16**	**0.12**	**0-0.33**	**0.11**	**0.086**
Hands		**0.74**	**0.71**	**0.4-1.27**	**0.53**	**0.51**
Head/Neck		**1.72**	**1.47**	**0.7-3.58**	**1.2**	**1.1**
Total Dermal		**13.21**	**9.69**		**9.4**	**7.1**
Respiratory		**0.0022**	**0**	**0-0.016**	**0.0016**	**0**

mg/lb ai = Exposure (mg) ÷ 1.4 lb ai

Calculation of Thiabendazole Exposures:

Assumptions:

(1) An average worker weighs 70 kg and has standard body surface areas and respiration rates as presented in the Pesticide Assessment Guidelines (7).

(2) A bushel of wheat weighs 60 lbs (3). A total of 60 bushels (5 mixings of 12 bushels each or 3600 lbs of seed) can be treated in 24 minutes with a 16 minute break (total 40 minutes), using parameters from the surrogate study.

(3) Examination of the Census of Agriculture data for Kansas yielded a median farm sizes of in the 100 to 249 acre range. Three other wheat producing states (North Dakota,

Washington, and Montana) had median farm sizes in the 250 to 499 acre range. A farm size of 500 acres was used for exposure calculations.

(4) Workers are assumed to wear the same clothing as those participating in the surrogate study. Many of the thiabendazole labels indicate that lindane (the surrogate chemical) is also part of the formulation. This clothing consists of a long sleeved shirt, long pants, and chemical resistant gloves.

(5) Wheat is planted at a rate of 120 pounds of seed per acre and each bushel of seed weighs 60 pounds (3). Therefore 2 bushels of seed would be planted per acre or 1000 bushels (120 lbs x 500 A = 60000 lbs) per farm. This is considered to be conservative since this seeding rate is primarily for winter wheat under humid conditions.

(6) Thiabendazole is applied at a rate of 0.005 lbs ai per 100 lbs seed (1 lb of a 0.5 percent formulation /100 lbs of seed). This is the maximum rate from a table of representative products for this chemical presented below. It must be noted that some of these products are for use in commercial seed treatment facilities rather than on farm treatment.

Application Rates of Some Products Containing Thiabendazole to Wheat.

EPA Reg. No.	lb TBZ/gal	Rate	lb ai/100 lbs seed
2935-471	0.05	2.5 fl oz/100 lbs	0.00098
2935-478	0.03	2 oz/bu (60 lbs)	0.0008
2935-478	0.03	6.6 fl oz/100 lbs	0.0015
2935-497	0.053	3 fl oz/bu (60 lbs)	0.0021
7501-166	0.13	5 fl oz/100 lbs	0.0051
7501-131	0.03	4 oz/100 lbs seed	0.00094
7501-135	0.03	4.4 fl oz/bu	0.0017
2935-498	1% (powder formulation)	2 oz/bu	0.002

Amount of seed treated per 8 hour day:

Seed treated (lbs) = 3600 lbs/40 min x 60 min/hr x 8 hrs/day

= 43200 lbs of seed/day

Amount of thiabendazole handled per day:

Lbs ai handled per day = 43200 lbs seed/day x 0.005 lbs ai/100 lbs seed

= 2.2 lbs ai/day

Estimation of Exposure (manual seed treatment):

Dermal:

Dermal Exposure (mg/kg/day) = 9.4 mg/lb ai x 2.2 lbs ai/day ÷ 70 kg x 0.60

= 0.18 mg/kg/day

Respiratory:

Respiratory Exposure (mg/kg/day) = 0.0016 mg/lb ai x 2.2 lbs ai/day ÷ 70 kg

= 0.00005 mg/kg/day

Total Exposure:

Total Exposure (mg/kg/day) = 0.18 mg/kg/day + 0.00005 mg/kg/day

= 0.18 mg/kg/day

The resulting MOE is:

MOE = 10 mg/kg/day ÷ 0.18 mg/kg/day = 56

III. EXPOSURES DURING COMMERCIAL SEED TREATMENT

The Agency has no data measuring the potential exposures of workers during commercial seed treatment operations and has addressed these exposures using data from a surrogate study found in the scientific literature.

CITATION: Grey, W.E., D.E. Marthre and S.J. Rogers (1983) Potential Exposure of Commercial Seed-treating Applicators to the Pesticides Carboxin-Thiram and Lindane. Bull. Environ. Contam. Toxicol. 31, 244-250.

Potential dermal and respiratory exposures to carboxin-thiram were monitored at 8 commercial seed conditioning operations. Lindane exposures were monitored at 2 additional sites. The site descriptions are presented below.

1) A small one-man operation. A liquid formulation was applied with a Panogen trip lever barrel treater at a rate of 3666 kg (8065 lbs) of grain per hour. The worker used his bare hand to remove excess treated grain from the barrel of the treater, resulting in high exposures to the hands. Treated grain was transferred directly into the truck box.

2) Another small operation using a Panogen trip lever barrel treater at a rate of 2200 kg (4840 lbs) of grain per hour. This operator wore gloves when cleaning out the treater barrel. Treated grain was transferred directly into the truck box.

3) A small grain elevator in which a Panogen trip lever barrel treater at a rate of 3200 kg (7040 lbs) of grain per hour. The operation stores grain as well as treating it. The operator wore gloves which were removed prior to hand rinse monitoring. Treated grain was transferred directly into the truck box.

4) A small operation at which grain was stored as well as treated. A Gustafson S -1000 treater was used to condition 5500 kg (12100 lbs) of barley per hour. The operator only wore gloves during transfer of fungicide from a new barrel to the pump system. Treated grain was transferred directly into the truck box.

5) An Experiment Station in which the treated grain was bagged. A Gustafson Mist-O-Matic treater applied the pesticides at a rate of 100 bags per hour, each weighing 27kg (5940 lbs/hr). during bagging the operator stood directly below a discharge chute holding an open bag. Dust and fungicide blew out of the bag into the operator's face. The operator normally did not wear a respirator, although one was used for monitoring purposes of the study.

6) A Gustafson S -1000 treater was used to condition 58000 kg (127600 lbs) of seed per hour. The plant was approximately 1 year old.

7) A Gustafson S -1000 treater was used in a new plant to condition 17000 kg (37400 lbs) of wheat per hour.

8) A large cleaning and treating plant using a Gustafson S -1000 to apply a 10% thiram /10% carboxin formulation. The application rate was13800 kg (30360 lbs) of wheat per hour. Two commercial seed cleaning machines were used, allowing the treater to operate at a high speed, cutting down exposure time. The applicator checked the uniformity of the treatment using his bare hands. Rubber gloves were worn when changing the fungicide barrels.

9) A large seed cleaning operation in which a dust formulation of maneb-lindane was applied using a hopper box attached to a Gustafson auger treater. The treatment rate was approximately 19411 kg (42704 lbs) per hour. The applicator was exposed to the dust when opening the 4.5 kg bag, during transfer of the dust into the hopper of the treated, and during discharge of the treated grain into the truck box.

10) A large modern seed cleaning and treating plant. A dust formulation of maneb-lindane was applied with a hopper attached to a Gustafson S -1000 treater. The operator wore a paper respirator but checked the uniformity of the application with his bare hands. Seed was treated at a rate of 17800 kg (39160 lbs) per hour.

A dermal exposure pad was attached to the sleeve of the shirt on the upper arm. A second pad was attached to the chest on the side opposite from the arm pad. Hand exposure was monitored by hand wash with 95 percent ethanol. Respiratory exposure was measured using modified respirators with an eight cm diameter pad on the filtering apparatus. Thiram and carboxin were quantified by HPLC using an UV detector. Lindane was quantified by GLC using a flame ionization detector. Recoveries from standard samples of thiram and carboxin were 99.7 and 100.6 percent, respectively. In situations where liquid formulations were used the residues on the chest and arm pads were below the level of detection. Chest and arm patches were also below the limit of detection for the dust formulations of lindane. Residues were detected on the hands of workers who handled treated grain with their bare hands and on the respirator pads for lindane. The results of exposure monitoring are presented in Table A5. Technical limitations of the study, most notably the lack of a sufficient number of dermal patches, prevent the quantification of exposures. Most of the exposure that was measure was on the hands. The study does, however, indicate that exposures from large scale seed treatment with commercial equipment is relatively low. The study was published in 1983. It is the Agency's understanding that current technology is such that the treatment system is closed and treatment systems are not manually operated. Therefore, exposures from a factory setting would not be expected to exceed that from manual seed treatment.

Table A5. Dermal and Respiratory Exposures of Individuals to Carboxin, Thiram or Lindane During Commercial Seed Treating Operations.

Site	Chemical	Exposure (mg/hr)			
		Chest	Arm	Hands	Respiratory
1	Thiram	<0.5	<0.5	3.70	<0.5
	Carboxin	<0.5	<0.5	8.20	<0.5
2	Thiram	<0.5	<0.5	1.34	No Sample
	Carboxin	<0.5	<0.5	2.40	No Sample
3	Thiram	<0.5	<0.5	<0.5	No Sample
	Carboxin	<0.5	<0.5	<0.5	No Sample
4	Thiram	<0.5	<0.5	<0.5	<0.5
	Carboxin	<0.5	<0.5	<0.5	<0.5
5	Thiram	<0.5	<0.5	2.24	0.75
	Carboxin	<0.5	<0.5	2.24	0.88
6	Thiram	<0.5	<0.5	<0.5	<0.5
	Carboxin	<0.5	<0.5	<0.5	<0.5
7	Thiram	<0.5	<0.5	<0.5	<0.5
	Carboxin	<0.5	<0.5	0.90	<0.5
8	Thiram	<0.5	<0.5	2.52	<0.5
	Carboxin	<0.5	<0.5	8.62	<0.5
9	Lindane	<0.1	<0.1	81.42	0.36
10	Lindane	<0.1	<0.1	54.80	0.54

IV. POST HARVEST APPLICATION TO CITRUS, POME FRUITS, MANGOES, BANANAS, SUGAR BEETS, PAPAYAS, POTATOES, CARROTS, SWEET POTATO SEED ROOTS, MUSHROOMS, AVOCADOS, ORNAMENTAL BULBS AND CORMS, RECONSTITUTED TOBACCO

Thiabendazole is applied as a post harvest treatment to apples, citrus, pears, and avocados as either a spray or during the waxing procedure. The equipment and procedures are essentially the same for all of the products and the exposure estimates are considered to be the same. A diagram of a typical operation is presented in Appendix A. Citrus is considered to be the most conservative estimate. That is, exposure from apple, pear, banana, sugar beet, papaya, or avocado treatment would not be expected to exceed that for citrus. Potential exposure can occur during the mixing/loading for such treatment or during the sorting/culling after application of the fungicide. Personnel are not in the proximity of the application but are generally 30-50 feet from the equipment. The labels specify that the rinse solution is to be discarded when dirty or used several times.

Mixer/Loaders preparing solutions for Commodity Treatment:

Assumptions:

1) A large operation can process up to 2000 boxes per hour, each weighing 90 lbs (8). While there are some differences between products, a typical product is applied at a rate of 212 grams of a 98.5 percent product in 192.5 gal of waxing solution. The material is applied at a rate of 1 gallon per 8000-10000 pounds of fruit. If fresh solution is used without recycling, the amount of thiabendazole handled at a facility would be:

Amount mixed/day (g ai/hr) = 2000 boxes/hr x 90 lbs/box x 1 gal/8000 lbs fruit x 212 g/192.5 gal x 0.985

= 24 g/hr = 0.054 lb ai/hr

For an eight hour shift the total amount mixed per day would be:

lb ai/day = 0.054 lb ai/hr x 8 hrs/day = 0.43 lb ai/day

2) An average worker weighs 70 kg with has standard surface areas and respiration rates as used by the Pesticide Handlers Exposure Database, V1.1.

3) Workers are assumed to wear long sleeved shirts long pants. Gloves are not assumed to be worn since many of the labels do not specify any protective clothing. In practice many workers do wear gloves so this scenario should be considered conservative.

4) Dermal absorption of thiabendazole is 60 percent (6).

5) Dermal and respiratory exposure values were obtained from the PHED Surrogate Guide (1). The unit exposures for a worker wearing a single layer of clothing with no gloves are 2.9 mg/lb ai and 0.0012 mg/lb ai for the dermal and respiratory routes, respectively.

The resulting exposures

Daily Dermal Exposure (mg/kg/day) = 2.9 mg/lb ai x 0.43 lb ai/day x 0.6 ÷70 kg

= 0.011 mg/kg/day

Respiratory Exposure (mg/kg/day) = 0.0012 mg/lb ai x 0.43 lb ai/day ÷70 kg

= 0.0000074 mg/kg/day

Total Exposure (mg/kg/day) = 0.011 mg/kg/day + 0.0000074 mg/kg/day

= 0.011 mg/kg/day

The resulting MOE is:

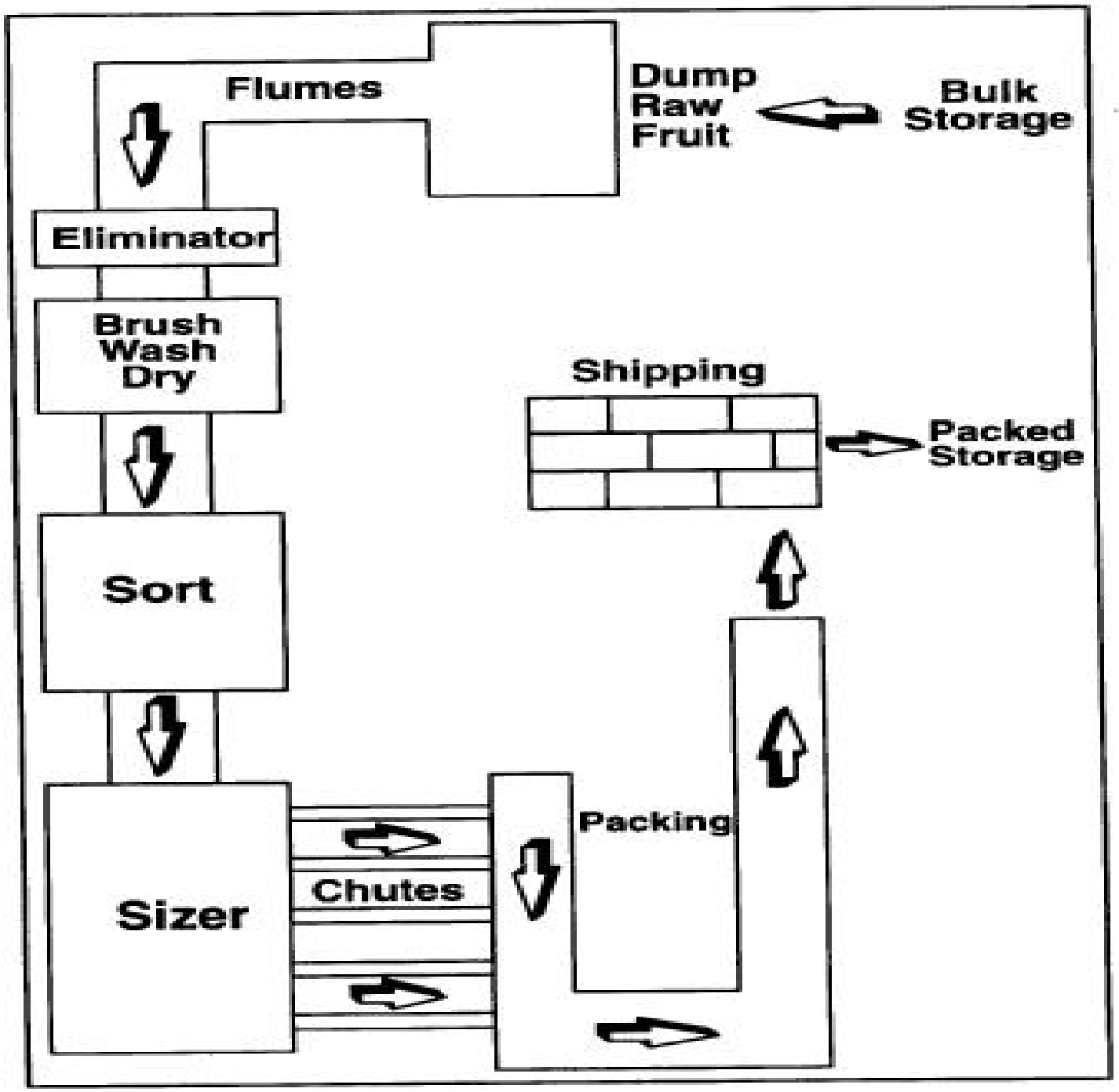
MOE=10 mg/kg/day ÷ 0.011 mg/kg/day = 910

The above estimates of exposure should be considered to be conservative for the following reasons; (1) workers are not assumed to wear any protective clothing while mixing/loading thiabendazole for post harvest treatments; (2) the material is not assumed to be recycled, in practice the chemical is recycled 3-5 times before new formulation is mixed; (3) the estimates are derived from citrus data, other commodities may not have the throughput associated with a large citrus packing plant.

Post Treatment During Sorting/Packing/Culling Operations

The Agency has no data addressing the sorting/culling/ or packing of products following thiabendazole treatment. The estimates of exposure were derived from residue chemistry data, surface area calculations, and a reentry study for citrus found in the scientific literature.

FIGURE 4.1. Typical Apple Packing Operations



CITATION: Nigg, H.N., J.H. Stamper, and R.M. Queen (1984) The Development and Use of a Universal Model to Predict Tree Crop Harvester Pesticide Exposure. Am. Ind. Hyg. Assoc J. 45:182-186.

Dermal exposure of ten harvesters to chlorbenzilate was monitored in a mature block of "Valencia" orange trees. The pesticide was applied using airblast equipment at the maximum label rate of 2.5 lbs ai per acre in 200 gallons of water. The ten harvesters wore cotton shirts with exposure pads pinned inside on both shoulders, chest, back, both forearms, and both upper arms. Thigh and shin pads were taped outside the work clothing. Hand exposures were monitored by hand rinse with 95 percent ethanol. Only the handwash data were used for the estimation of thiabendazole exposure to sorters and packers on an assembly line. Dislodgeable foliar and fruit residues were collected on days 1,2,3,4, and 7 after treatment. The dislodgeable residues on fruit remained fairly constant on days 1 to 3, followed by a large decrease on day 4. Exposure data were only presented for days 2, 3, and 4 and only the data from days 2 and 3 were used for estimation of TBZ exposure. The exposures of the hands are presented in Table A6.

Table A6. Exposure of the Hands of Workers Harvesting Citrus 2 and 3 Days After Application of Chlorbenzilate. Dislodgeable residues for the 2 days were 0.103 µg/cm² for day 2 and 0.129 µg/cm² for day 3, averaging 0.12 µg/cm². Values are in µg/hr.

Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Mean
40	58	227	37	85	210	953	33	159	54	186
169	98	170	39	36	42	1050	71	70	89	183
										185

The resulting transfer coefficient **for the hands only** would be:

Transfer Coefficient, TC (cm²/hr) = 185 µg/hr ÷ 0.12 µg/cm² = 1500 cm²/hr

This assumes that the entire hand, both front and back, is exposed to residues. In reality it is likely that only the palmar surfaces would be exposed to commodities on a conveyor belt. Therefore one half of the hand area would be exposed yielding a transfer coefficient of 750 cm²/hr.

The estimated residues on the surfaces of treated commodities were estimated using the following assumptions:

1) A "standard" apple has a diameter of 2-3/4 inches (~7 cm) and weighs 138 grams (9). It is assumed that other products such as oranges, limes, grapefruit, pears, etc have approximately the same characteristics as apples.

2) The treatment equipment for all post harvest treatments with thiabendazole is essentially the same for all products.

3) The residue level in an apple or other commodity is 3.4 ppm (µg/g). This was obtained from the highest average field trial (HAFT) for apples (10).

4) All of the thiabendazole in an apple or other commodity is located on the surface. The fungicide is not applied as a systemic product. All of the material is transferable. This should be considered to be very conservative.

5) Workers are assumed to perform the sorting/culling tasks for 8 hours per day.

The amount of thiabendazole in an apple would be:

Thiabendazole (µg/apple) = 3.4 µg/g x 138 g/apple = 469 µg

6) The surface area of a 7 cm diameter sphere is:

$$\text{Surface Area} = 4 \times 3.14 \times (7/2 \text{ cm})^2 = 154 \text{ cm}^2$$

The residue value for thiabendazole would therefore be:

$$469 \text{ µg}/154 \text{ cm}^2 = 3.0 \text{ µg/cm}^2$$

With a transfer coefficient of 750 cm^2/hr the dermal exposure becomes:

Dermal exposure (µg/kg/day) = 750 cm^2/hr x 3.0 µg/cm^2 x 8 hrs/day ÷ 70 kg x 0.6

= 154 µg/kg/day = 0.15 mg/kg/day

The resulting MOE would be:

$$\text{MOE} = 10 \text{ mg/kg/day} \div 0.15 \text{ mg/kg/day} = 67$$

If gloves, offering 90 percent protection are worn the dermal exposure becomes 0.015 mg/kg/day and the resulting MOE is 670 It is HED's understanding that gloves are commonly worn (but not always), although not required by the label for the sorting/culling process.

The exposure estimate derived in lieu of data should be considered to be very conservative for the following reasons: (1) **it was assumed that the transfer of thiabendazole on the treated surface is the same as that from the surrogate study. The chemical is often part of a wax matrix and transfer to the skin may be very different from that of the surrogate chemical** (2) the transfer coefficients for the hands were obtained from a field study in which contact with contaminated foliage was high. A conveyor belt treatment line would be unlikely to have such a high degree of contact (probably restricted to fingertips or palmar surface only).

V. PAINT, AND ADHESIVE USES

Thiabendazole is registered as an additive to paints and adhesives, primarily wallpaper adhesives. The products are added to paints at a rate of 10 grams of product (25-50% active ingredient) to a gallon of paint which is then shaken. For the 50 percent product the final concentration of thiabendazole in the mixed paint/adhesive would be:

$$\text{lb ai/gal} = 10 \text{ g formulation/gal} \times 0.5 \div 454 \text{ g/lb} = 0.011 \text{ lb ai/gal}$$

The material is dispensed from either a hand-operated pump or in the form of a pouch containing 10 grams of formulation. Alternatively, some labels allow the mixing of the thiabendazole formulation during the formulation process for the paint. These scenarios are considered to be closed and yield negligible exposures. The vapor pressure of thiabendazole is very low, yielding no appreciable post application exposures. Exposure could occur during the application of the paint or adhesive. It is assumed that application of either of these materials would yield the same exposure. The use of paintbrush and airless sprayers are addressed in the PHED Surrogate Exposure Guide (1). The estimated dermal exposures for individuals wearing a single layer of clothing and no gloves are 180 mg/lb ai and 38 mg/lb ai for the paintbrush and airless sprayer, respectively. The paintbrush dermal exposure data are considered to be low to medium confidence and the airless sprayer to be high confidence. The corresponding respiratory exposures 0.28 mg/lb ai and 0.83 mg/lb ai and are both considered to be of medium confidence.

The Agency's Residential SOPs (11) indicate that 2 gallons of paint are used during a single painting event in which a paintbrush is used. The corresponding value for airless sprayers is 5 gallons per day. The amount of thiabendazole (TBZ) handled per day would be:

<u>Paintbrush Application:</u>

$$\text{lb TBZ/day} = 2 \text{ gal/day} \times 0.011 \text{ lb ai/gal} = 0.022 \text{ lb TBZ/day}$$

the resulting dermal exposure of a 70 kg individual, assuming 60 percent dermal absorption (6) would be:

Dermal Exposure (mg/kg/day) = 180 mg/lb ai x 0.018 lb ai/day ÷ 70 kg x 0.60

= 0.034 mg/kg/day

The respiratory exposure would be:

Respiratory Exposure (mg/kg/day) = 0.28 /mg/lb ai x 0.022 lb ai/day ÷ 70 kg

= 8.8×10^{-5} mg/kg/day

The total exposure for the paintbrush scenario is:

Total Exposure (mg/kg/day) = 0.034 mg/kg/day + 7.2×10^{-5} mg/kg/day

= 0.034 mg/kg/day

The NOAEL for approximately 10 mg/kg/day for both short term dermal (1-7 days), intermediate term (9.4 mg/kg/day for 1 week to several months, considered to be 10 for calculation purposes), and inhalation for any time period (6). The resulting Margin of Exposure (MOE) is therefore:

MOE = 10 mg/kg/day ÷ 0.034 mg/kg/day = 290

Airless Sprayer Application:

lb TBZ/day = 5 gal/day x 0.011 lb ai/gal = 0.055 lb TBZ/day

the resulting dermal exposure of a 70 kg individual, assuming 60 percent dermal absorption would be:

Dermal Exposure (mg/kg/day) = 38 mg/lb ai x 0.055 lb ai/day ÷ 70 kg x 0.60

= 0.018 mg/kg/day

The respiratory exposure would be:

Respiratory Exposure (mg/kg/day) = 0.83 /mg/lb ai x 0.055 lb ai/day ÷ 70 kg

$= 6.5 \times 10^{-4}$ mg/kg/day

The total exposure for the airless sprayer scenario is:

Total Exposure (mg/kg/day) = 0.018 mg/kg/day + 6.5×10^{-4} mg/kg/day

= 0.018 mg/kg/day

The resulting Margin of Exposure (MOE) is therefore:

MOE = 10 mg/kg/day ÷ 0.018 mg/kg/day = 560

VI. APPLICATION TO MUSHROOM HOUSES

HED has no data directly measuring the exposures of applicators using thiabendazole in mushroom houses. Thiabendazole is applied to mushroom houses during watering or by coarse spray. Of these coarse spray application is considered to yield the higher potential for exposure and the exposure assessment is limited to this scenario. There are no data with which to address post application exposures but they would be expected to be less than those for a coarse spray applicator and would likely be close to those of post harvest workers. Post harvest exposures were included in the section on post harvest treatment of other commodities.

The estimates of the surface areas treated were obtained using information found in a mushroom culture textbook (12). These parameters may not be applicable for all sites. In lieu of specific data it was necessary to use assumptions to estimate the surface areas of beds and tables, the areas that would be treated by coarse spray applicators. This creates a degree of uncertainty in the exposure estimates.

The label directs the user to apply a solution containing 3.8 lbs ai per gallon at a rate of up to 8 fluid ounces per 1000 ft^2 for the first application either as a coarse spray or during watering. A maximum of 20 fluid ounces is allowed per crop. Mushroom house application is considered to be an intermediate exposure scenario with a NOAEL of 10 mg/kg/day.

A typical mushroom operation is believed to consist of 10 houses, each with a volume of 30000 ft^3 (850 m^3) (13). HED has no data regarding the surface areas of mushroom houses in the United States. The volume of a typical mushroom house in the Netherlands is 342 m^3 (12073 ft^3) with a growing volume of 5 beds. Each of these growing beds has an internal dimensions of 13.8 m x 1.34 m, giving a surface area of:

Surface Area (m^2) = 13.8 m x 1.34 m

= 18.5 m^2 = 199 ft^2

Mushroom houses in the United States are about 2.5 times larger (30000 ft^3/12073 ft^3) Assuming that the relative area of the beds to house volume in the United States is the same as that in the Netherlands, the estimated area sprayed would be:

Estimated Area (ft^2) = 199 ft^2 x 2.5 = 498 ft^2 ≈ 500 ft^2

Therefore, at the 8 ounce/1000 ft^2 rate the amount to be applied to a mushroom house would be:

Amount per house (lb ai/house) = 8 oz/1000 ft^2 x 500 ft^2/house x 1 gal/128 oz x 3.8 lb ai/gal

= 0.12 lb ai per house

The daily amount handled for someone treating 10 houses is therefore 1.2 lb ai/day.

Unit exposures for applicators were obtained from the PHED Surrogate Data Guide (1). These are considered to be low confidence data sets. The dermal and respiratory exposure estimates for low pressure handwand application for workers with a single layer of clothing without gloves are 12 mg/lb ai and 0.940 mg/lb ai, respectively. The corresponding unit exposures of mixer/loaders open pouring liquids are 2.9 mg/lb ai and 0.0012 mg/lb ai. If gloves are worn the corresponding dermal value for appliactors is 7.1 mg/lb ai and that of mixer/loaders is 0.023 mg/lb ai. The resulting daily exposures would be:

Dermal Exposure(Mushroom, Mixing/loading, Without gloves):

Dermal Exposure (mg/kg/day) = 2.9 mg/lb ai x 1.2 lb ai/day ÷ 70 kg x 0.6

= 0.030 mg/kg/day

Dermal Exposure(Mushroom, Mixing/Loading, With gloves):

Dermal Exposure (mg/kg/day) = 0.023 mg/lb ai x 1.2 lb ai/day ÷ 70 kg x 0.6

= 0.00024 mg/kg/day

Respiratory (Mushroom, Mixing/Loading):

Respiratory Exposure (mg/kg/day) = 0.0012 mg/lb ai x 1.2 lb ai/day ÷ 70 kg

= 0.000021 mg/kg/day

Total exposures and resulting MOEs are:

Without gloves:

Total Exposure (mg/kg/day) = 0.030 mg/kg/day + 0.000021 mg/kg/day

= 0.030 mg/kg/day

MOE = 10 mg/kg/day ÷ 0.030 mg/kg/day = 330

With gloves:

Total Exposure (mg/kg/day) = 0.0024 mg/kg/day + 0.000021 mg/kg/day

= 0.0024 mg/kg/day

MOE= 10 mg/kg/day ÷ 0.0024 mg/kg/day = 4200

Dermal Exposure (Mushroom Spraying, Without gloves):

Dermal Exposure (mg/kg/day) = 12 mg/lb ai x 1.2 lb ai/day ÷ 70 kg x 0.6

= 0.12 mg/kg/day

Dermal Exposure (Mushroom Spraying, With gloves):

Dermal Exposure (mg/kg/day) = 7.1 mg/lb ai x 1.2 lb ai/day ÷ 70 kg x 0.6

= 0.073 mg/kg/day

Respiratory (Mushroom Spraying):

Respiratory Exposure (mg/kg/day) = 0.94 mg/lb ai x 1.2 lb ai/day ÷ 70 kg

= 0.016 mg/kg/day

Total exposures and resulting MOEs are:

Mushroom Spraying (Without gloves):

Total Exposure (mg/kg/day) = 0.12 mg/kg/day + 0.016 mg/kg/day

= 0.13 mg/kg/day

MOE = 10 mg/kg/day ÷ 0.13 mg/kg/day = 77

Mushroom Spraying (With gloves):

Total Exposure (mg/kg/day) = 0.073 mg/kg/day + 0.016 mg/kg/day

= 0.089 mg/kg/day

MOE = 10 mg/kg/day ÷ 0.089 mg/kg/day = 112

VII. POST APPLICATION EXPOSURE TO TREATED CARPETS, CANVAS, AND PAPER PRODUCTS

Thiabendazole is occasionally applied as part of the manufacturing process for some paper products, canvas textiles, and incorporated into carpets. The Agency has no data addressing the potential exposures of individuals to these products. The fungicide is applied during the manufacturing process to non-food paper products, canvas textiles such as tents and awnings, and nylon carpet. Carpet would probably yield the highes contact. The material is applied via a trough during the manufacturing process to achieve a final level of 0.02-0.1% (paper), 0.05-0.3% (canvas), or 0.025-0.25% (nylon carpeting), based on finished product weight. The Agency has no data relating the weight of these products to the surface areas that could potentially lead to exposure. In lieu of such data an exposure estimate was derived from a study in the scientific literature measuring exposures of individuals performing activities on carpets following actuation of a total release fogger. It is assumed that surface application in a residential environment would exceed that from application during the manufacturing process and that exposure from carpeting would exceed the potential exposure from canvas or paper products. Only the portions addressing the surface amounts of the compounds are summarized below. It is recognized that the extrapolation from this study is highly uncertain and required several **unsubstantiated** assumptions:

1) It is assumed that the levels of Thiabendazole in the carpet, textiles or paper products are similar to those resulting from actuation of a total release fogger. **The uncertainty associated with this is very high.**

2) Levels remaining in the carpet do not dissipate. Individuals are exposed to the levels found on the first day after treatment.

3) Five percent of the residues found on the treated carpets are available for transfer to the skin (14).

4) The assumed transfer coefficients are 16500 cm^2/hr for adults, 6000 cm^2/hr for toddlers, and 6000 cm^2/hr for infants.(14).

5) The duration of exposure is 8 hours per day (11).

6) Dermal absorption is assumed to be 60 percent (6).

The Dermal Exposures were calculated using the following equation:

Exposure (mg/kg/day) = Residue (µg/cm^2) x TC x D x Transfer factor x Absorp ÷ BW

where:

Residue = 1.8 µg/cm^2 for Chlorpyrifos and 0.18 µg/cm^2 for d-trans allethrin

TC = transfer coefficient (16500 cm^2/hr for adults, 6000 cm^2/hr for toddlers, 6000 cm^2/hr for infants)

D = duration of exposure, 8 hours

Transfer factor = percent transferred from surface to skin, 5% (0.05)

Absorp = dermal absorption factor, 0.6

BW = body weight (70 for adults, 15 for toddlers, 10 for infants)

The exposures and resulting MOEs are presented in Table 4.

It must be noted that the residue data used for this exposure estimate was obtained from a study in which the materials were <u>sprayed</u> on the carpet and the areas contacted within a short period of time. <u>Thiabendazole is applied during manufacture</u> and much of the material would very likely to be bound to the backing and therefore inaccessible. The carpet is also often stored for a period of time before installation. It has been the Agency's experience that pesticides on carpets bind to the carpet material over time and are not readily dislodgeable. This can be seen in Table 4. The estimates presented here should therefore be considered <u>very conservative</u>.

The surface residue portion of the literature citation is presented below:

CITATION: Ross, J., T. Thongsinthsak, H.R. Fong, S. Margetich, R. Krieger (1990) Measuring Potential Dermal Transfer of Surface Pesticide Residues Generated from Indoor Fogger Use: An Interim Report. Chemosphere, V20, Nos 3/4, p 349-360.

The study was conducted in a hotel in Sacramento, CA. Most of the furniture was removed from the rooms and a small entry vestibule sealed with polyethylene film to provide a more uniformly flat surface area. Air conditioners were turned off during application. Carpets were 100 percent nylon. The fogger was placed on a polyethylene covered cinder block to elevate it from the carpet. Newspaper was placed between the fogger and the newspaper.

Five volunteers participated in the study. The subjects wore underclothing, tights (36% polyester, 54% cotton, and 10% spandex), a long sleeve cotton T-shirt, thin 100% cotton gloves, and cotton athletic socks. Aluminum collection sheets (400 cm^2) were placed 1 meter from each corner but away from the activity area. In addition, a gauze pad (exposed area 23.76 cm^2) was placed adjacent to each aluminum sheet.

The study was conducted in 8 rooms, 6 treated and 2 controls. Two hours after actuation of the foggers the rooms were ventilated by opening 2 bay windows and turning on the fan only of the air conditioner . Each room was ventilated for 30 minutes after which the windows were again closed. Reentry occurred 0.5 hours (2 rooms and controls) or 12.5 to 13.5 hours (4 rooms) after ventilation. Researchers ventilating the rooms or performing other tasks wore disposable surgical foot covers to avoid cross contamination.

At the appropriate times the test subjects entered the rooms wearing the dosimeters described above and foot covers to avoid cross contamination. These were removed at the threshold and used again upon exit. Fresh coverings were used for each entrance/exit cycle. The subjects entered preassigned areas, avoiding the fogger area and away from the room dosimeters. The subjects then performed a series of 4 Jazzercise® routines, lasting a total of about 20 minutes. Following the routines the subjects removed their gloves and placed them in plastic bags, and covered their hands with PVC gloves. After recovering their feet with the surgical foot coverings the subjects went to an untreated room where they removed the rest of their dosimetry clothing. They then discarded their PVC gloves and donned fresh dosimetry clothing for the next exposure sequence. The gloves tights and shirts were placed in individually marked plastic bags. All dosimeter clothing was stored on dry ice. The foggers were weighed to determine the amount dispensed. All samples were sent to the CDFA Laboratory Services for analysis.

The samples were analyzed for chlorpyrifos, oxon, and d-trans allethrin. Foil and cotton matrices were placed in jars large enough to allow a sufficient amount of ethyl acetate (1000 mL for aluminum, 750 mL for small cotton items, and 2500 mL for large cotton items) for residue extraction. The samples were rotated on a mechanical rollers for 30 minutes and analyzed by gas chromatography using an electron capture detector. The recovery results are summarized in Table A7. The results of surface monitoring are presented in Tables A8 and A9 for chlorpyrifos and allethrin, respectively.

The amount of chemical transferred to the dosimeters decreased with time after venting. These data are summarized in Table 10. The resulting estimates of exposure are presented in Table A11.

Table A7. Summary of Recovery Values for Dosimeters Used in Fogger Study. The levels of detection are in parentheses.

Item	Spike Level (mg)	Chlorpyrifos	Oxon	d-trans Alletrhin
Shirt	0	(5)	(10)	(25)
	5	100	105	104
Tights	0	(5)	(10)	(25)
	5	95	98	100
Socks	0	(5)	(2)	(5)
	1	102	104	104
Gloves	0	(1)	(2)	(5)
	1	100	97	101
Gauze	0	(1)	(2)	(5)
	0.1	102	105	105
Foil	0	(0.2)	(0.4)	(1)
	0.4	102	105	102

Table A8. Residues of Chlorpyrifos on Surface Dosimeters Located in the Corners of Rooms Following Actuation of a Total Release Fogger.

Room ID	Right Near		Right-Far		Left-Near		Left-Far		Mean	
	Alum	Gauze	Alum	Gauze	Alum	Gauze	Alum	Gauze	Alum	Gauze
A0	1.35	1.51	2.66	2.77	1.30	1.68	2.38	2.90	1.92	2.21
B0	2.16	2.36	3.27	3.75	2.06	1.57	1.69	2.34	2.29	2.50
A6	1.59	2.65	1.34	2.23	1.62	2.70	0.78	1.30	1.33	2.22
B6	2.85	4.75	0.28	0.47	1.75	2.92	0.88	1.47	1.44	2.40
A12	1.18	2.34	0.81	2.08	0.93	2.20	0.20	1.75	0.78	2.09
B13	0.53	1.83	0.52	1.99	0.60	1.94	0.31	2.02	0.49	1.94

Table A9. Residues of d-trans Allethrin on Surface Dosimeters Located in the Corners of Rooms Following Actuation of a Total Release Fogger.

Room ID	Right Near		Right-Far		Left-Near		Left-Far		Mean	
	Alum	Gauze	Alum	Gauze	Alum	Gauze	Alum	Gauze	Alum	Gauze
A0	0.15	0.16	0.31	0.28	0.15	0.17	0.28	0.28	0.22	0.22
B0	0.20	0.20	0.32	0.31	0.21	0.14	0.16	0.20	0.22	0.21
A6	0.25	No Sample	0.23	No Sample	0.25	No Sample	0.14	No Sample	0.22	No Samples
B6	0.40	No Sample	0.11	No Sample	0.28	No Sample	0.18	No Sample	0.24	No Samples
A12	0.24	0.28	0.20	0.24	0.20	0.25	0.10	0.19	0.19	0.24
B13	0.17	0.23	0.19	0.26	0.19	0.26	0.16	0.25	0.18	0.25

Table A10. Mean Amounts of Chlorpyrifos and d-trans Allethrin Found on Dosimeter Clothing Following Activities After Treatment of the Room with a Total Release Fogger.

chlorpyrifos:

Time Post-Venting and Room ID	Amount Found (µg) Tights	Shirt	Socks	Gloves	Total
0 hr/Rm A	1229	1043	754	459	3485
0 hr/Rm B	1192	946	1025	570	3733
6 Hr/Rm A	857	664	563	320	2404
6 Hr/Rm B	853	557	706	372	2488
12 Hr/Rm A	497	319	381	163	1360
13 Hr/Rm B	298	274	268	117	957

d-trans Allethrin:

TimePost-Venting and Room ID	Amount found (µg) Tights	Shirt	Socks	Gloves	Total
0 hr/Rm A	108	97	76	60	341
0 hr/Rm B	102	86	106	68	362
6 Hr/Rm A	85	73	67	48	273
6 Hr/Rm B	91	72	86	60	309
12 Hr/Rm A	55	45	40	23	163
13 Hr/Rm B	40	39	30	23	132

Table A11. Estimated Exposures of Individuals to Thiabendazole in Treated Carpets.

Individual	Chemical	Residue (µg/cm²)	Transfer Factor	Transfer Coeff. (cm²/hr)	Duration (hrs)	Absorp (%/100)	BW (kg)	Exposure[1] (mg/kg/day)	MOE
Adult	Chlorpyrifos	1.80	0.05	16500	8	0.60	70	0.10	100
	Allethrin	0.18	0.05	16500	8	0.60	70	0.01	1000
Toddler	Chlorpyrifos	1.80	0.05	6000	8	0.60	15	0.17	59
	Allethrin	0.18	0.05	6000	8	0.60	15	0.02	590
Infant	Chlorpyrifos	1.80	0.05	6000	8	0.60	10	0.26	39
	Allethrin	0.18	0.05	6000	8	0.60	10	0.03	330

[1]Exposure (mg/kg/day) = $\frac{\text{Residue (µg/cm²) x Trans Coeff. (cm²/hr) x Duration (hrs) x Trans Fact x Absorp}}{\text{1000 µg/mg x BW (kg)}}$

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